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Investigation of GDM flooding effects on PEMFC performance

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Computational Fluid Dynamics (CFD) is gaining more interest as a tool to understand fuel cell performance[1-4]. The model calculations provide insight into the fuel cell on a local level and describe distributions of current, heat, and water. Thus, modeling will help in gaining an understanding of the mechanisms inside the fuel cell, aid in data analysis, and identify limiting parameters.

Three-dimensional (3D) Computational Fluid Dynamics (CFD) simulations of a PEM Fuel Cell[1] were performed for a 25 cm^2 single cell with triple serpentine flow channels as shown in Fig. 1. The purpose of this study was to investigate the effect of gas diffusion media (GDM) flooding on fuel cell performance. As an alternative technique to solving the completed two-phase flow description in both flow channels and GDMs, the flooding effect can be simulated by a stationary liquid water phase inside the micro and macro GDMs (illustrated in Fig. 2). The effect of this liquid water phase is a reduction of the open volume fraction, which reduces the effective gas diffusivity of the GDMs. Various levels of flooding of micro and macro GDMs were studied and the results are compared to the non-flooded base case.

Fig. 3 shows the total cell performance at 65^{o}C cell temperature, 100% relative humidity, 0 psig back pressure, and anode and cathode stoichiometry of 1.2 and 2.0 at 644 mA/cm^2, respectively. The calculations indicate that flooding of the micro layer GDM results in lower performance than flooding of the macro layer with the same percentage of water flooding. Detailed distributions on the MEA surface will be presented to investigate this effect. This alternative technique to estimate the effect of GDM flooding gives reasonable predictions with less computational time than the full two-phase flow calculations.

References

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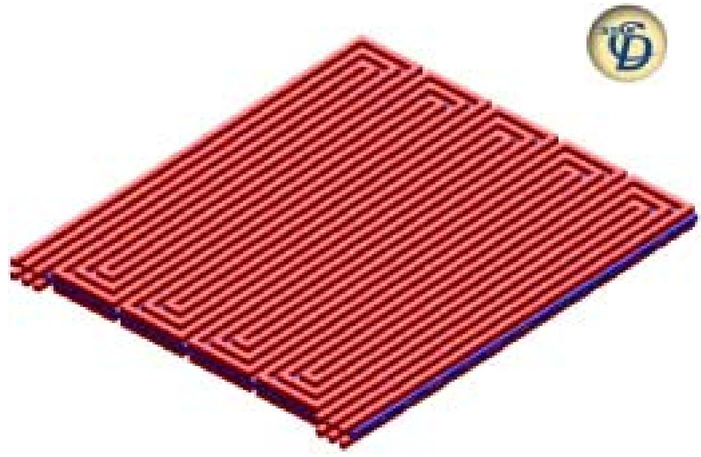

Figure 1. The geometrical model of the 25-cm^2 triple serpentine flowfield.

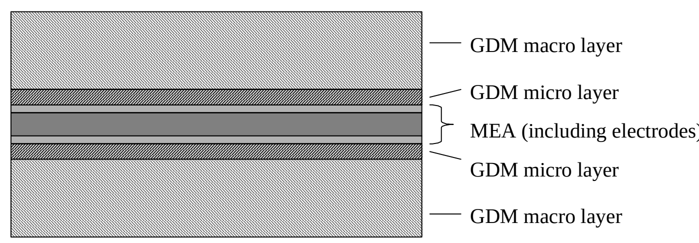

Figure 2. Schematic representation of GDM layers and the MEA.

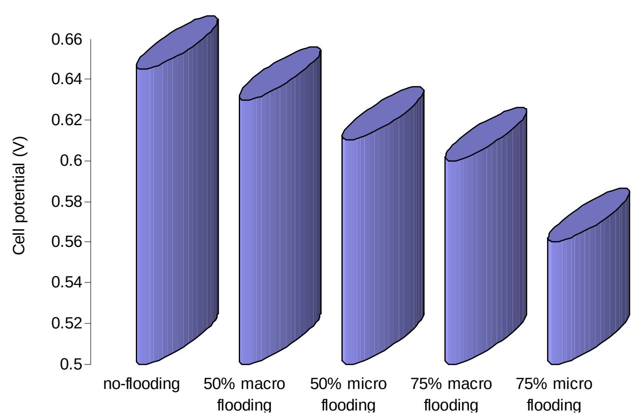

Figure 3. Comparison of cell potential at Iavg = 644 mA/cm2 with different percentage of water flooding.